

MOVEMENT AND HARVEST OF GIANT CANADA GEESE IN EAST TENNESSEE

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ABSTRACT. Giant Canada Geese (*Anser canadensis maxima*) are generally considered to be non-migratory residents throughout the southeastern United States, although biologists have known for some time that Canada Geese in the southeast move long distances (e.g., from north Alabama to Akimiski Island in Canada). To better understand movements of Canada Geese in east Tennessee, we developed a database to track first- and last-known dates and locations of geese that were banded near the Department of Energy's Oak Ridge Reservation. Legband recovery data were also obtained from the U.S. Geological Survey's Bird Banding Laboratory in Laurel, Maryland. Approximately 1% of the nearly 3,000 geese that we tracked are known to have moved outside the State of Tennessee. We estimate that ~5% of Giant Canada Geese in central east Tennessee actually move outside the state and the other 95% are probably permanent residents. The known hunter harvest rate for geese in this study is ~18%, with the actual harvest estimated at 32%. Twenty-eight geese that we documented traveling outside of Tennessee were found in 11 other states and four Canadian provinces.

INTRODUCTION

Canada Geese of the giant race (*Anser canadensis maxima*) were first introduced into east Tennessee on Melton Hill Reservoir in 1972 (Nicholson 1997) after being extirpated from Tennessee sometime near the turn of the century (Hanson 1965). The geese breeding in Tennessee belong to this race, the largest goose in the world (Mowbray et al. 2002), although the Tennessee Valley population also contains members of the interior race (*A. c. interior*) (Bellrose 1980). The Canada Goose population in east Tennessee expanded throughout the 1970s and 1980s, and the population on the Department of Energy's Oak Ridge Reservation (ORR) was estimated at 1,500 birds in 1990 (Beauchamp and Pollock 1995). Five hundred and six geese were translocated off the ORR from 1995-1999, and we estimate the current population to be approximately 1,400.

Canada Goose roundups have been conducted annually on the ORR since 1988 and in other east Tennessee locations since shortly after their introduction in 1972. Individually coded neck collars were first placed on geese of the ORR in summer 1989, one year after the first legbands were used. Roundups were generally conducted during the last week of June, but varied from mid-June to mid-July, a period that coincides with a month-long flightless stage caused by a simultaneous wing molt (Palmer 1976).

The objectives of this study were to determine travel destinations of migrant Canada Geese that were banded in central east Tennessee, to determine the percentage of this population that moves outside the state, and to estimate the hunter harvest rate for this population. We use the term "migrant" to refer to geese known to move outside the State of Tennessee, but make no attempt to differentiate between migration, emigration, and movements of geese between states. We use the term "resident" to refer to geese that are not known to travel outside the State of Tennessee.

STUDY AREA

The ORR consists of the Oak Ridge National Environmental Research Park and land associated with Department of Energy (DOE) facilities in Oak Ridge, Tennessee. This reservation is approximately 13,900 ha and lies in the Ridge and Valley province, a physiographic region characterized by underlying formations of dolomite, limestone, and shale (Miller 1974). ORR elevations range from 229-384 m mean sea level, and the area is bordered on the south and west by the Clinch River/Melton Hill Reservoir (ORNL 2002). Approximately 70% of the ORR is in forest (principally native eastern deciduous) and 20% in old fields, agricultural areas, cutover forest lands, roadsides, and utility corridors (Washington-Allen et al. 1995). Geese in this area are primarily using water bodies, maintained grass and grassland (hay) habitats, corridor rights-of way, and sparsely vegetated or maintained lawn habitats associated with DOE security areas. The geese tracked in this study were banded in Anderson and Roane Counties in east Tennessee, on or near the ORR, from 1988-2001, or were sighted or recaptured here prior to March 2003. Destinations of migrant geese in this study include 11 states and four Canadian provinces (Fig. 1).

METHODS

Capture Technique and Banding Procedures

The summer roundups begin by herding the geese into pens that are temporarily set up at sites with concentrations of geese. Although materials and designs for capture pens have varied over the years, the capture method basically consists of the drive-trapping technique described by Cooch (1953).

Geese were generally released on site after aging and sexing by cloacal examination (Hanson 1949, 1967), recording recaptures, and attaching legbands and neck collars. Age at the time of banding was recorded as HY (hatching year) or AHY (after hatching year). HY birds at the time of capture are approximately eight to ten weeks old and are known to be resident birds incapable of flight. AHY birds could be any age of approximately 14 months or more; most are thought to have hatched in the ORR area but some may have hatched elsewhere. Initial banding locations for geese ($n = 2971$) in this study include 2,857 birds banded in Anderson and Roane Counties, 33 banded in east Tennessee outside these counties, two banded in middle Tennessee near Nashville, and 79 banded at locations unknown to the authors.



Figure 1. Approximate destinations of 28 Canada Geese banded in Anderson and Roane Counties, Tennessee, 1988-1999.

Uniquely-numbered size-8 aluminum legbands and hard plastic, cylindrical-type (7 cm x 5 cm diameter) neck collars were used. Neck collars were white with individually coded combinations of black letters and numbers. Goslings that were too small to hold neck collars were fitted with legbands and collared, if recaptured, in subsequent years. Procedures and materials used in this study were in accordance with the guidelines established by Rusch et al. (1990), the North American Bird Banding Program (Gustafson et al. 1997), and the Oak Ridge National Laboratory Animal Care and Use Committee (Protocol No. 0311). Nuisance geese have periodically been transported to off-site locations by Wildlife Services of the U.S. Department of Agriculture.

Data Management, Surveys, and Bird Banding Laboratory Returns

ORR waterfowl monitoring surveys have been conducted routinely since 1990 at varying intervals, ranging from once/month to once/week. Survey procedures (Roy et al. 2001) include the recording of all observations of Canada Geese and associated neck collars, and survey data from January 1994 through March 2003 were included in this study.

Records of 2,971 Giant Canada Geese that were banded, recaptured, or sighted in Anderson or Roane Counties were entered into a computer spreadsheet. We attempted to document the first- and last-known dates and locations of as many of these geese as possible. The majority of first-known dates and locations resulted from banding efforts conducted on or near the ORR. The majority of last-known dates and locations resulted from survey efforts and band returns reported by waterfowl hunters.

University of Tennessee Wildlife and Fisheries students conducted waterfowl hunter surveys on Melton Hill Reservoir from the 1991-92 through 1993-94 goose hunting seasons. These surveys documented 41 kills of banded Canada Geese, 24 of which had not been reported to the U.S. Geological Survey's Bird Banding Laboratory (BBL) in Laurel, Maryland. Additional hunter harvest data (516 reported kills) were retrieved from recovery reports received by the BBL. This study includes harvest data from the 1988-89 through 2001-02 hunting seasons. Also extracted from the BBL data were any reports of sightings, recaptures, or geese found dead from the ORR flock. Legband recovery data were included for all geese known to have used the ORR from 1988-2003, although BBL data were only current as of August 2002. Because harvest data were not included after the 2001-02 hunting season, geese which were newly captured and banded in summer 2002 or later were not included in the dataset.

Locations were generally recorded in 10-minute latitude/longitude blocks, defined by coordinates at the southeast corner of each block. Travel distances noted in Table 1 were calculated from the banding location to the center of the 10-minute recovery block using an online distance calculator. Distance estimates for select movements were verified using cartographic techniques. These distance estimates represent one-way flights, and it is worth noting that migrating Canada Geese typically follow relatively direct flight paths (Mowbray et al. 2002).

Harvest Reporting Rate

The Michigan Department of Natural Resources conducted a mail survey of waterfowl hunters following the 1998-99 hunting season. When survey results were extrapolated over the total number of goose hunters, an estimated $20,458 \pm 3,216$ goose bands were recovered and $10,973 \pm 1,864$ were reported during the three-year study period (Soulliere and Frawley 2001). We believe this 53.6% reporting rate to be reasonably accurate and have chosen it to calculate harvest estimates and the percent of migrant geese in the ORR population.

Reporting rates from waterfowl hunters for harvested legbands are typically cited in the 30-60% range, with rates having improved since the implementation (in 1995) of a 24-hr toll-free number for reporting recovered bands (MNDNR 1997). Although our data include some pre-1995 band recoveries, we used the Soulliere and Frawley reporting rate estimate because it is specific to goose hunters and is based on a large sample size.

RESULTS

Six hundred fifty-nine of the geese in this study are now documented as dead, including seven of those banded outside Anderson and Roane Counties. None of the 79 geese of unknown origin are known to have died. Disposition of the 659 known-dead geese is as follows: 540 harvested by hunters, 69 sacrificed for scientific study, 28 road-killed, 20 found dead of unknown causes, one train-killed, and one handling mortality.

Most movements of ORR Canada Geese occurred along a northerly vector, with east Tennessee representing the southern terminus of nearly all movements. Three geese recovered from northeast Alabama were not included in this study because they had been translocated in 1993 from the ORR to Nickajack Lake, only six kilometers northeast of the Tennessee-Alabama state line. These three geese were recovered within 40 km of the Nickajack release location. However, two other translocated geese are included in Table 1 because of significant flights made after translocation. Goose # 848-47715 made a flight of ~297 km to Arkansas, after being translocated ~394 km west to McNairy County, Tennessee, and goose # 878-56277 made a flight of ~545 km to Ohio, after being translocated ~40 km southeast to Monroe County, Tennessee. For consistency, travel distances and headings for these two geese (as with all geese) are represented in Table 1 as occurring between banding location and point of recovery, although clearly, any translocation effort can significantly impact these estimates. While a few geese made significant non-northerly movements, including those recovered in Arkansas, South Carolina, and Texas, all other recoveries came from areas north of the banding location (Fig. 1). Most movements occurred almost due north, as evidenced by the fact that more than half of the band recoveries came from Michigan, Ohio, and Ontario.

The dataset has many examples of geese for which their last-known locations occur in the same 10-minute block in which they were banded. Giant Canada Geese are somewhat unusual in that certain individuals travel or migrate long distances, while other individuals in the same population can be documented as almost never moving more than several kilometers. Only 28 of the 2,971 geese (<1%) were ever found outside Tennessee; these were documented in 11 other states and four Canadian provinces (Table 1). Twenty-five of these 28 geese were harvested by hunters, two were recaptured out-of-state, and one was a sight record reported to the BBL. It is not known if any of the three non-harvested geese in Table 1 are still alive, although all are known to have returned to the ORR. The most recent sighting of these geese came from # 868-42667 in November 2003. The longest-known flight (a one-way straight-line distance of 1,940 km) of a goose in this study was from the ORR to Nunavut, Canada and back to the ORR (Table 1). There were no reports (i.e., sightings, recaptures, or band recoveries) of 1,165 geese after their initial capture, indicating that some travels may represent classic migratory movements.

Table 1. Destination or location of harvest, legband number, age at banding, sex, age at harvest, distance traveled, and heading for 28 Canada Geese banded in Anderson and Roane Counties, Tennessee, 1988-1999 (band numbers in bold type are recapture or sight records; all others are hunter-harvested geese).

Destination	Band	Age-B ¹	Sex	Age-H ²	Dist ³ km (mi)	Heading ⁴
Arkansas	848-47715 ⁵	AHY	M	5	691 (429)	259.8° W
Indiana	818-41291	HY	F	3	NA ⁶	NA
Kentucky	808-71071	HY	F	2	234 (145)	335.9° NNW
Michigan	818-41342	HY	F	1	763 (474)	5.7° N
	868-42667	HY	F	11	1203 (747)	353.6° N
	828-75658	HY	F	3	677 (421)	346.4° NNW
	848-47760	HY	F	1	NA	NA
	828-03133	HY	M	1	1154 (717)	354.5° N
	828-77093	AHY	F	5	834 (518)	2.8° N
	828-76527	AHY	M	10	705 (438)	4.5° N
New Jersey	868-42411	AHY	M	4	963 (599)	63.2° ENE
Ohio	828-77033	HY	F	1	567 (352)	5.0° N
	878-56277 ⁵	HY	F	1	520 (323)	30.5° NNE
	578-55975	HY	M	1	485 (301)	17.1° NNE
	828-75809	AHY	M	2	672 (418)	23.8° NNE
	848-47730	AHY	M	3	509 (316)	28.4° NNE
Pennsylvania	828-77295	AHY	F	2	839 (521)	53.4° NE
South Carolina	868-42636	AHY	M	2	194 (121)	143.8° SE
Texas	828-75626	HY	M	8	1493 (928)	255.2° WSW
Vermont	808-70825	AHY	M	10	1303 (810)	42.6° NE
Virginia	828-77299	AHY	F	5	198 (123)	70.3° ENE
Nunavut Can.	828-75988	AHY	F	4	1940 (1206)	6.0° N
Ontario Can.	828-76589	HY	F	1	723 (449)	15.5° NNE
	828-77016	HY	F	1	1210 (752)	15.7° NNE
	828-76701	HY	M	5	1004 (624)	22.7° NNE
	828-77078	AHY	M	2	1829 (1136)	6.2° N
Manitoba Can.	828-77247	AHY	M	6	1902 (1182)	330.4° NNW
Quebec Can.	828-77074	AHY	M	3	1651 (1026)	20.7° NNE

¹ AGE-B: Age at time of initial banding; HY = hatching year, AHY = after hatching year

² AGE-H: Age at time of harvest or last sighting; minimum number of whole years bird is known to have survived

³ DIST: Minimum one-way straight-line distance traveled

⁴ HEADING: Compass direction of straight-line travel from banding location to known destination

⁵ Translocated prior to harvest

⁶ NA: Data not available because of inexact reporting of harvest location

Student surveys of waterfowl hunters (conducted locally in the field) found only 41.5% (17 of 41) of these recovered bands were reported by hunters to the BBL, the U.S. Fish and Wildlife Service, or state wildlife agency. These data may be biased in that hunters may feel less compelled to "officially" report recovered bands after sharing the information with surveyors. The small sample size and potential reporting bias are reasons not to base hunter harvest estimates on this 41.5% reporting rate. Nonetheless, this rate lies within the 30-60% range, and as might be expected based on pre-1995 data, is less than the 53.6% rate reported by Soulliere and Frawley (2001).

We know that 18.2% (540/2971) of the banded geese in this study were harvested by hunters, yet the expected harvest rate (e) is calculated to be 32.4%, as determined by the following equation;

$$e = r / 0.536p$$

where r = reported harvest, 0.536 = reporting rate, and p = banded population

Although 540 geese were known to be harvested in this study, only 516 were actually reported (the other 24 were only learned of through student surveys); thus $r = 516$, $p = 2971$, and $e = 0.324$.

The actual number of hunter-harvested geese in this study is estimated to be 963, determined by multiplying the expected harvest rate (e) by the banded population (p). Given the paucity of public hunting venues in east Tennessee, we were surprised to learn that 18.2% of the geese in this study were harvested by hunters, and that the actual harvest was expected to be 32.4%. Using a lower reporting rate, such as the 41.5% rate calculated from field surveys, would result in an even higher expected harvest.

Because 25 geese are known to have traveled outside the state and been harvested by hunters (y), the number of geese expected to be harvested out-of-state (x) is 47, as determined by the following equation;

$$x = y / 0.536$$

The expected number of migrant geese in the population (m) is approximately 145, as determined by the following equation;

$$m = x / e$$

The percent of migrants in the population is estimated to be 4.9%, determined by dividing the expected number of migrants in the population (m) by the banded population (p). A similar estimate is calculated by dividing the 25 geese reported as harvested out-of-state by the total reported harvest of 516 birds. In other words, 4.8% (25/516) of the reported harvest occurs outside Tennessee, and we assume this value also represents the percentage of unharvested geese occurring outside the state. From these calculations, it follows that slightly more than 95% of the population are resident birds which rarely, if ever, leave the State of Tennessee.

DISCUSSION

As Canada Geese migrate, more geese are potentially available to harvest in northern states than in southern states because geese are shot during migration

and some individuals winter in northern states (Hestbeck 1994). Given that Tennessee is a southern state, one might expect a lower harvest rate for ORR geese than for northern states or for an entire flyway. A possible equalizing factor, however, is that most southern states experience longer goose hunting seasons than do northern states. Even though we estimate that only ~5% of ORR geese migrate, the 32.4% expected hunter-harvest rate we calculated for these geese is remarkably similar to flyway harvest estimates calculated by J. B. Hestbeck (Hestbeck 1994, LaRoe et al. 1995).

A 31% harvest rate was calculated by Hestbeck, as a three-year average, for Canada Geese in the Atlantic Flyway (LaRoe et al. 1995). This estimate was for the 1990-92 period, which occurred during our ORR study, and was down slightly from the 34% harvest rate that he estimated for the 1982-84 period. These estimates are calculated by dividing the estimated U.S. flyway harvest by the estimated flyway fall flight (Hestbeck 1994). Although Tennessee is considered part of the Mississippi Flyway, we documented flights of east Tennessee geese to five Atlantic Flyway states, four of which were included in Hestbeck's studies: New Jersey, Pennsylvania, South Carolina, and Virginia.

Hestbeck's estimates represent an annual harvest whereas our harvest estimate was calculated by examining a specified period of time (~15 yrs) to determine how many geese that were banded were also harvested during this period. His estimates also address harvest at the flyway-level whereas ours is applicable to a much smaller, regional scale. Although we did not calculate an annual harvest rate in our study, we would expect it to be slightly less than the 32.4% rate we estimated during the study period. It is interesting to note that these two very different approaches to estimating harvest rates have lead to nearly identical estimates.

If we continue to analyze legband recovery data reported after 2002 (without also inputting data for newly applied legbands), our 32.4% harvest estimate would increase. This increase is not expected to be large, however, and the rate of increase would slow over time, as young geese are more vulnerable to harvest than are adults (Hestbeck 1994). Our study corroborates this fact, as half of the harvested migrant geese from the ORR were in the 2+ year class or younger (Table 1), and 326 of the total 540 known harvest (60%) were in this cohort.

Our data suggest that the ORR goose population has been increasing in recent years after being down slightly from levels seen in the early 1990s. This temporary wane appeared to be a regional occurrence, likely attributable, in part, to aggressive translocation efforts in the late 1990s. The timely proposal to grant states increased flexibility in managing Canada Geese (U.S. Fish and Wildlife Service 2003) will likely prove necessary in controlling east Tennessee's goose population.

We believe our sample size is sufficient to conclude that most (~95%) ORR Canada Geese are non-migratory residents and that this population is subjected to significant hunting pressure (~32% harvest). Our calculations are dependent

on the Soulliere and Frawley reporting rate, and on accurate reporting and recording of legband data. While these findings should not be construed to be indicative of conditions throughout Tennessee, we believe this study accurately reflects, albeit presumptively, the movements and harvest of Giant Canada Geese in the eastern part of the state.

ACKNOWLEDGMENTS

Special thanks go to everyone who assisted with goose roundups, waterfowl surveys, and reporting of legband returns, including R.L. Allen, R.A. Anderson, T.W. Beatty, L.D. Bible, K.M. Blanton, J.S. Carbaugh, M.T. Carr, M.L. Coffey, D.K. Cox, R.L. Dailey, M.D. DeFord, R.J. Dickey, J.P. Donnelly, S.H. Harmon, R.P. Hoffmeister, J.F. Hughes, A.D. Hurd, K.E. Kitzmiller, J.D. Lane, B.W. Layton, E.N. Lewis, S.R. Lewis, P.J. Lindbom, D.R. Lindbom, M.K. McCracken, J.M. Mitchell, K.L. Morgan, B.R. O'Neal, D.G. Page, D.W. Parsons, J.G. Peryam, R.B. Petrie, L.E. Reddick, L.B. Ryon, M.G. Ryon, E.M. Schilling, P.A. Scofield, M.R. Smith, E.L. Warr, J.B. Watson, J.W. Webb, H.B. White, and S.H. Young. We thank S.A. Dean, M.D. DeFord, G.W. Jones, B.J. Schiller, A. Silvis, J.L. Toney, and E. P. Willey for providing valuable assistance with data entry. We thank H.K. Gibbs for verification of distance estimates, D.J. Roy for providing Figure 1, and J.M. Loar, M.J. Peterson and M.G. Ryon for valuable comments on an early draft.

We thank the following agencies for their cooperation and support of this research: Appalachian Regional Commission, Bechtel Jacobs Company LLC, Bird Banding Laboratory - U.S. Geological Survey, Oak Ridge National Laboratory, Tennessee Department of Environment and Conservation, Tennessee Technological University, Tennessee Wildlife Resources Agency, University of Tennessee, U.S. Department of Energy, U.S. Fish and Wildlife Service, UT-Battelle LLC, and Wildlife Services - U.S. Department of Agriculture.

LITERATURE CITED

- BEAUCHAMP, J.J., and K.H. POLLOCK. 1995. Summary report on analysis of ORNL Canada goose recapture and resighting data. Internal correspondence of Martin Marietta Energy Systems, March 28, 1995. Oak Ridge National Laboratory, Oak Ridge, Tn.
- BELLROSE, F.C. 1980. *Ducks, Geese and Swans of North America*. Stackpole Books, Harrisburg, Pa.
- COOCH, F.G. 1953. Technique for mass capture of flightless blue and lesser snow geese. *J. Wildl. Manage.* 17:460-465.
- GUSTAFSON, M.E., J. HILDENBRAND, and L. METRAS. 1997. *The North American Bird Banding Manual* (Electronic Version). Version 1.0.
- HANSON, H.C. 1949. Methods of determining age in Canada geese and other waterfowl. *J. Wildl. Manage.* 13:177-183.
- _____. 1965. *The giant Canada Goose*. Southern Illinois University Press, Carbondale.
- _____. 1967. Characters of age, sex, and sexual maturity in Canada geese. *Ill. Nat. Hist. Surv. Biol. Notes* 49:1-15.
- HESTBECK, J.B. 1994. Survival of Canada geese banded in winter in the Atlantic Flyway. *J. Wildl. Manage.* 58(4):748-756.

- LAROE, E.T., G.S. FARRIS, C.E. PUCKETT, P.D. DORAN, and M.J. MAC, eds. 1995. Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals and ecosystems. U.S. Dept. Interior, National Biol. Serv., Washington, D.C.
- MILLER, R.A. 1974. The geologic history of Tennessee. *Tenn. Div. Geol. Bull.* 74. Nashville.
- MNDNR. 1997. Fish & Wildlife Today: Fall 1997 @ Minn. Dept. Nat. Res., St. Paul.
- MOWBRAY, T.B., C.R. ELY, J.S. SEDINGER, and R.E. TROST. 2002. Canada Goose (*Branta canadensis*). In A. Poole and F. Gill, eds. *The Birds of North America*, No. 682. The Birds of North America, Inc., Philadelphia, Pa.
- NICHOLSON, C.P. 1997. *Atlas of the Breeding Birds of Tennessee*. University of Tennessee Press, Knoxville.
- ORNL. 2002. Oak Ridge National Laboratory Land and Facilities Plan, August 2002. ORNL/TM-2002/1. Oak Ridge National Laboratory, Oak Ridge, TN.
- PALMER, R.S., ed. 1976. *Handbook of North American Birds*, Vol. 2. Yale University Press, New Haven, CT.
- ROY, W.K., J.W. EVANS, and M.G. RYON. 2001. The red-headed woodpecker and brown-headed nuthatch on the Oak Ridge Reservation: relationship to recent landscape changes. *Migrant* 72(1):1-12.
- RUSCH, D.H., G.W. SWENSON, and B.D. SULLIVAN. 1990. A Manual for the Collection of Canada Goose Neckband Data in the Mississippi Flyway. Wisconsin Coop. Wildl. Res. Unit, Univ. Wisconsin, Madison.
- SOUILLERE, G. J. and B. J. FRAWLEY. 2001. Michigan waterfowl hunter activity and opinions on regulations, management, and satisfaction, 1998-1999. Wildl. Rep. No. 3357. Michigan Dept. Nat. Res., Lansing.
- U.S. FISH & WILDLIFE SERVICE. 2003. Migratory Bird Hunting and Permits; Regulations for Managing Resident Canada Goose Populations, 50 CFR Parts 20 and 21. Fed. Register 68(162). U.S. Dept. Interior, Washington, D.C.
- WASHINGTON-ALLEN, R. A., T. L. ASHWOOD, S. W. CHRISTENSEN, H. OFFERMAN, and P. SCARBROUGH-LUTHER. 1995. Terrestrial Mapping of the Oak Ridge Reservation: Phase I. ES/ER/TM-152. Oak Ridge National Laboratory, Oak Ridge, TN.